

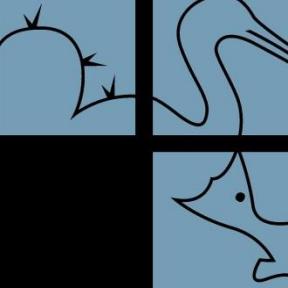
Assessing the effects of freshwater inflows and other key drivers on the population dynamics of blue crab and white shrimp using a multivariate time-series modeling framework

Dr. Edward J. Buskey

Dr. Lindsay P. Scheef

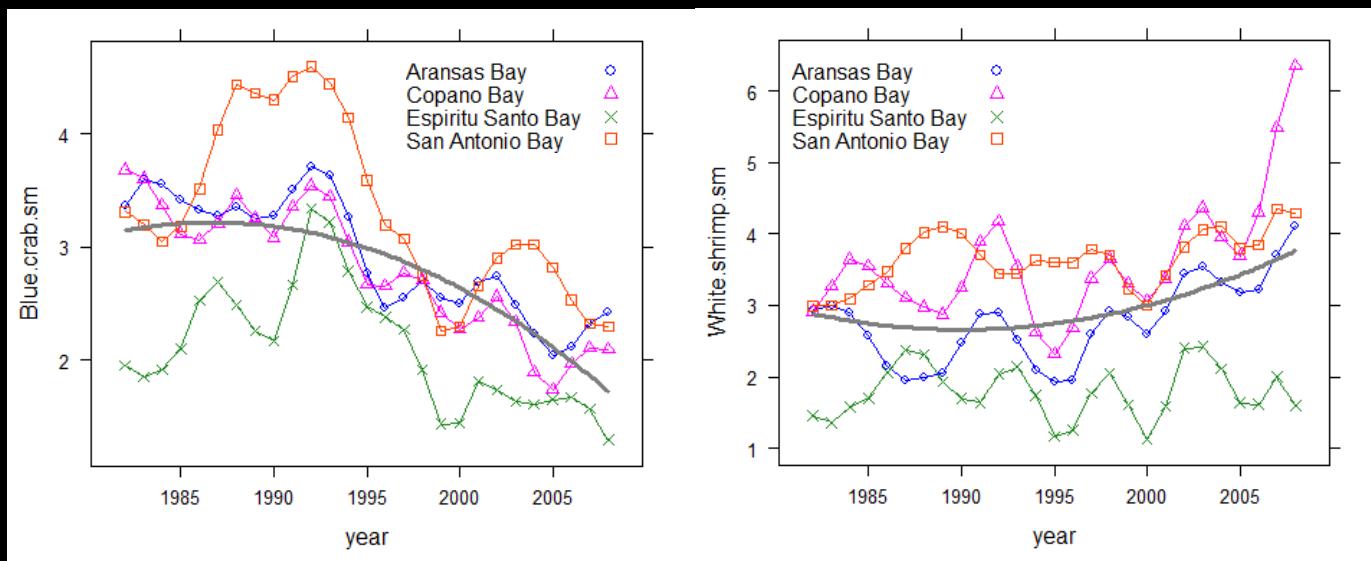
Dr. Jianhong Xue

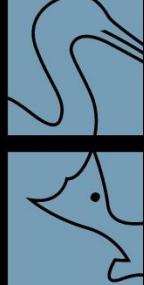
Sara Smith



Project Goals

- Compose a review of literature examining blue crab and white shrimp populations
- Assess the drivers of blue crab and white shrimp population dynamics using multivariate autoregressive (MAR) models
 - Texas Parks and Wildlife Department Coastal Fisheries monitoring data

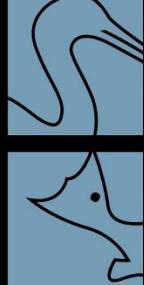




Project Timeline

Literature review

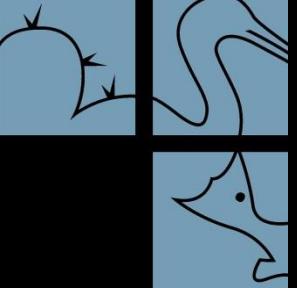
Tentative timeline	Accomplishments
2014 Apr-Jul	<ul style="list-style-type: none">✓ Compose annotated bibliography✓ Outline structure for review
2014 Aug-Dec	<ul style="list-style-type: none">✓ Complete annotated bibliography✓ Begin literature review report
2015 Jan-Mar	<ul style="list-style-type: none">• Continue composition of literature review report
2015 Apr-Aug	<ul style="list-style-type: none">• Complete final literature review• Present results at final workshop• Submit final report• Submit manuscript for publication



Project Timeline

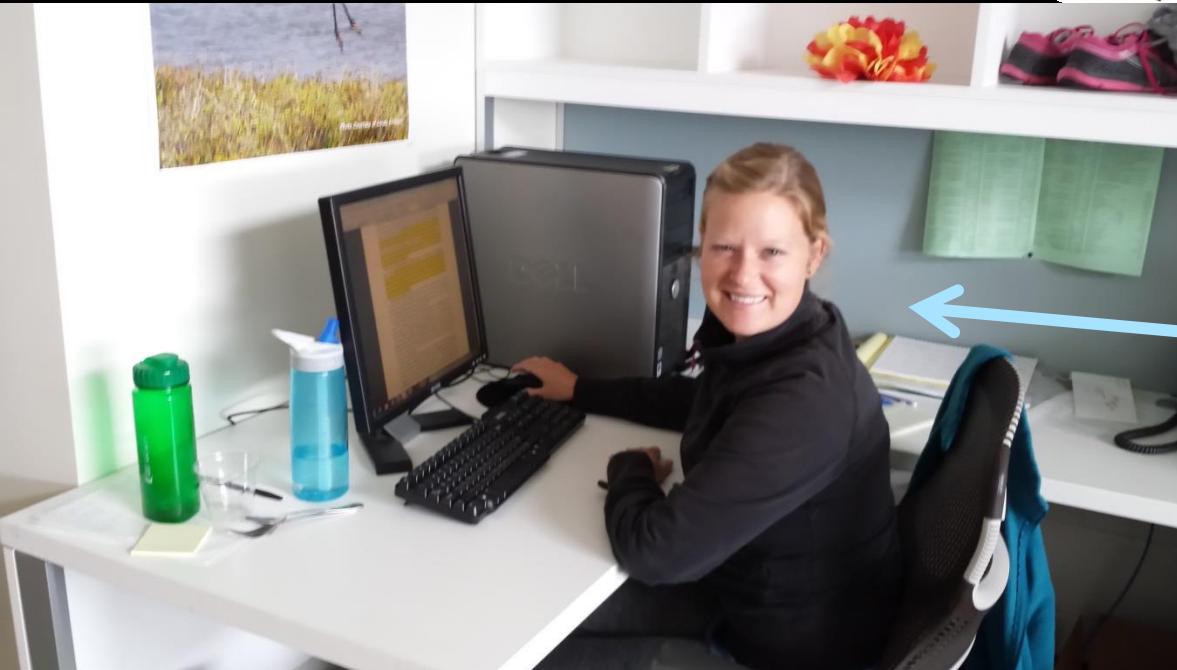
Data analysis

Tentative timeline	Accomplishments
2014 Apr-Jul	<ul style="list-style-type: none">✓ Acquire and prepare datasets for model application
2014 Aug-Dec	<ul style="list-style-type: none">✓ Meet with data managers and analysts✓ Continue to prepare datasets for model application• Construct and assess preliminary models
2015 Jan-Mar	<ul style="list-style-type: none">• Select and apply final models to data• Compose data analysis report
2015 Apr-Aug	<ul style="list-style-type: none">• Prepare final report• Present results at final workshop• Submit final report• Submit data and annotated R code

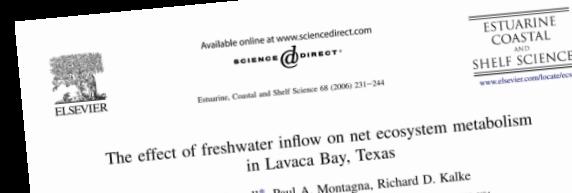


Methods

Literature review



Sara



The effect of freshwater inflow on net ecosystem metabolism
in Lavaca Bay, Texas

Marc J. Russell*, Paul A. Montagna, Richard D. Kalke
— of Texas Marine Science Institute, 780 Channel View Drive, Port Aransas, TX 78373, USA
—> Submitted 2005; accepted 26 January 2006
—> April 2006

Inshore Environmental Effects on Brown Shrimp,
Penaeus aztecus, and White Shrimp, *P. setiferus*,
Populations in Coastal Waters, Particularly of Texas

ZOULA P. ZEIN-ELDIN and MAURICE L. RENAUD

Introduction

Many states have instituted water management plans that may control freshwater inflow to various coastal bays and marshes, the normal estuarine habitats of species important to marine fisheries. Knowledge of the tolerance ranges

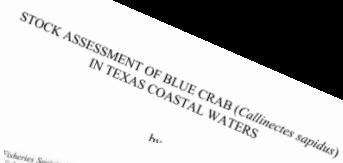
of the present extent of this information; Figure 1 further identifies those areas and life stages requiring additional research. Each table contains information specific to either *P. aztecus* or *P. setiferus*.

Our discussion compares and contrasts responses of the two species to

ing animals only as "juvenile" shrimp without size classification have been included in defining field ranges of that

Discussion

Early studies of the Penaeidae were limited chiefly to white shrimp (Lin-



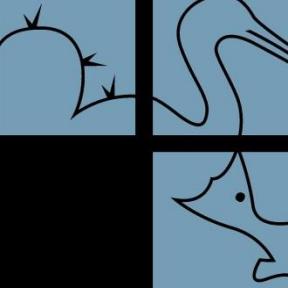
Fisheries Society 128:499–506, 1999
© Fisheries Society 1999

Effect of Temperature and Salinity on Size at Maturity of Female Blue Crabs

MARK R. FISHER*
is Parks and Wildlife Department,
School Road, Austin, Texas 78744, USA

nets were used to collect 15,517 female blue crabs from nine 987. Carapace width, water temperature, salinity, and maturity zebra. Logistic regression revealed that carapace width, salinity, reducers of maturity. The logistic model is accurate, correctly f the time. Probability of maturity increases with increasing after sizes as temperature and salinity increase. At 25°C, size is 139 mm at 10%, 121 mm at 20%, and 112 mm at 30%. At of including environmental factors in estimating and using

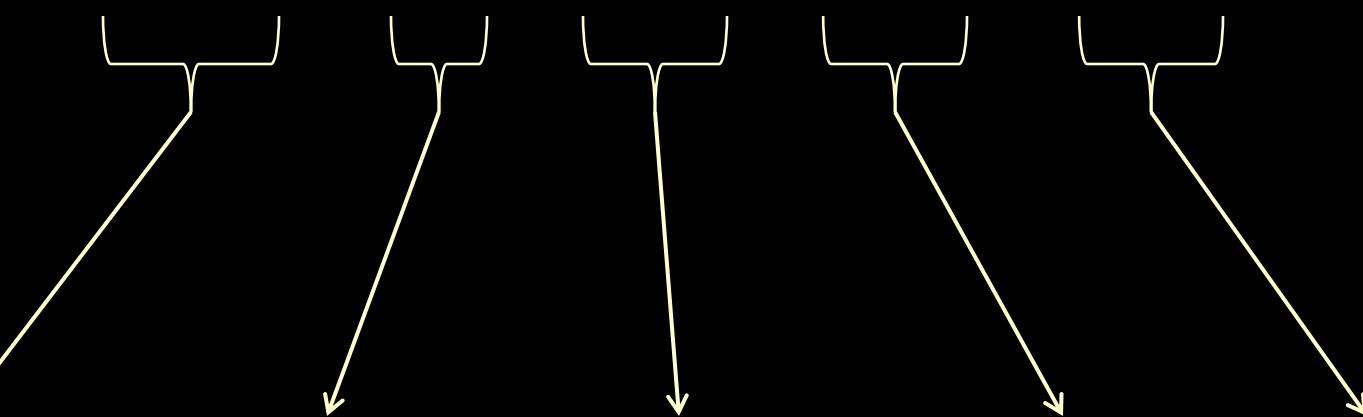


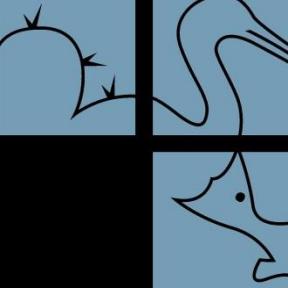


MAR-1 Model

$$X_{t+1} = A + BX_t + CU_t + E_t$$

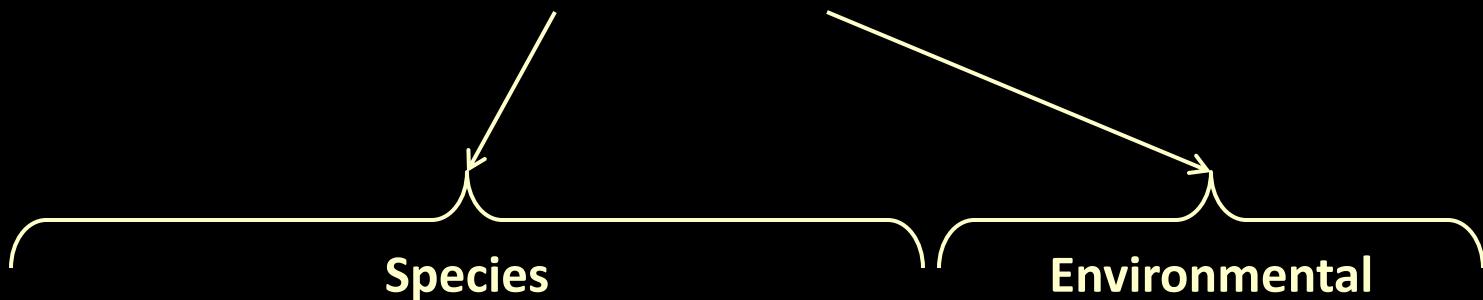
Next abundance = Constant + Influence of each species + Influence of other factors + Error



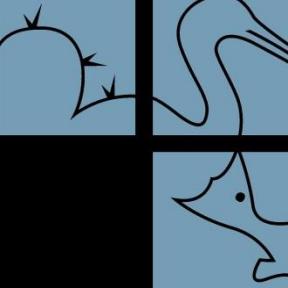


MAR-1 Model

$$X_{t+1} = A + \mathbf{B} X_t + \mathbf{C} U_t + E_t$$

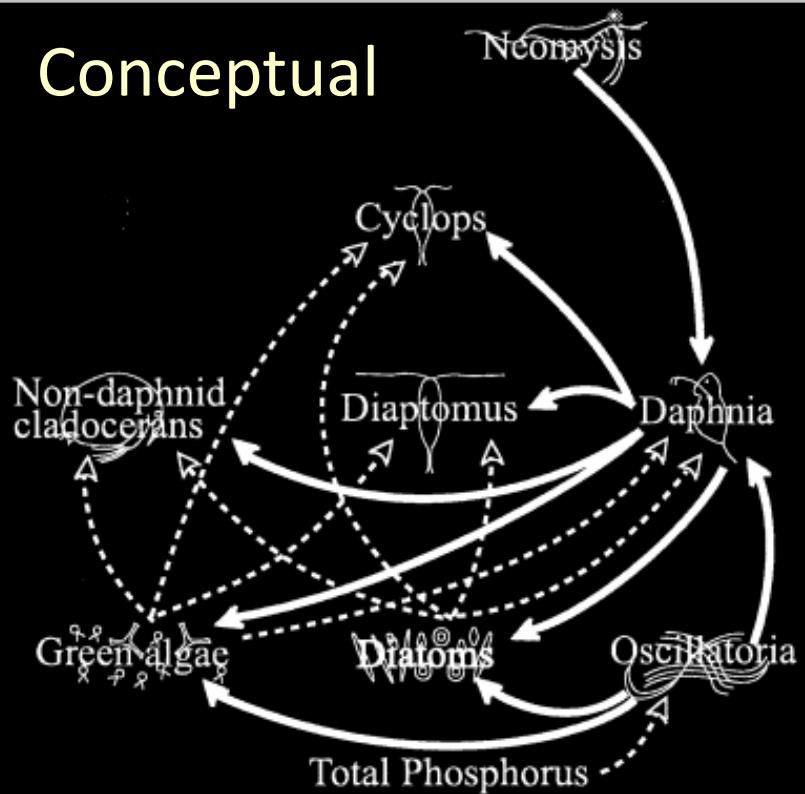


Species	1	2	3	...	p	1	...	q
1	$b_{1,1}$	$b_{1,2}$	$b_{1,3}$	...	$b_{1,p}$	$c_{1,1}$	...	$c_{1,q}$
2	$b_{2,1}$	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	$c_{2,1}$	...	$c_{2,q}$
3	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$

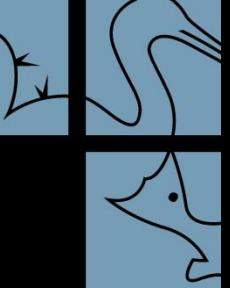


Interaction webs from MAR-1 analysis

Conceptual

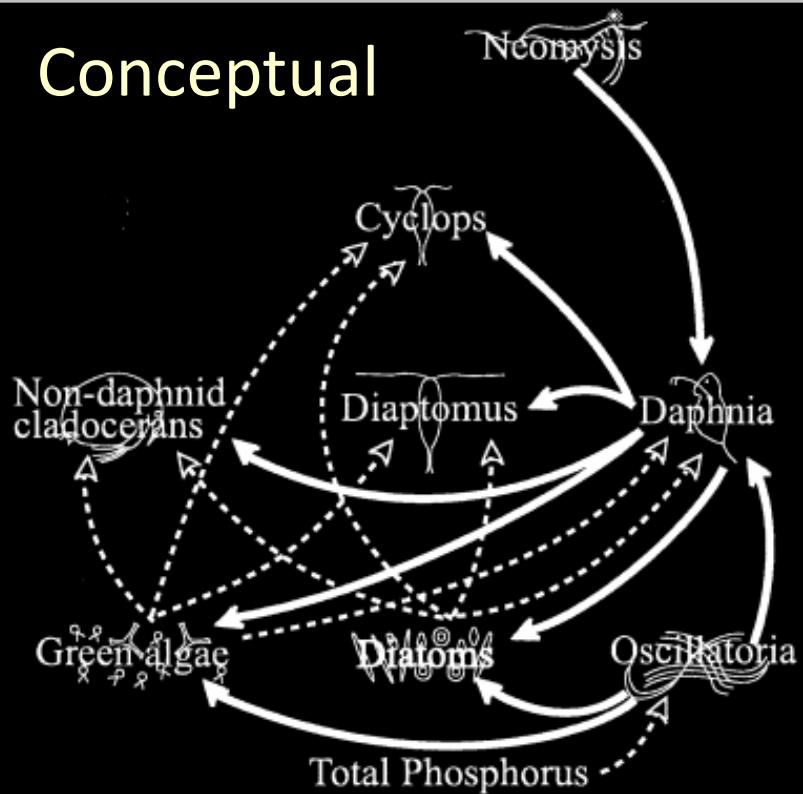


Hampton et al. 2006

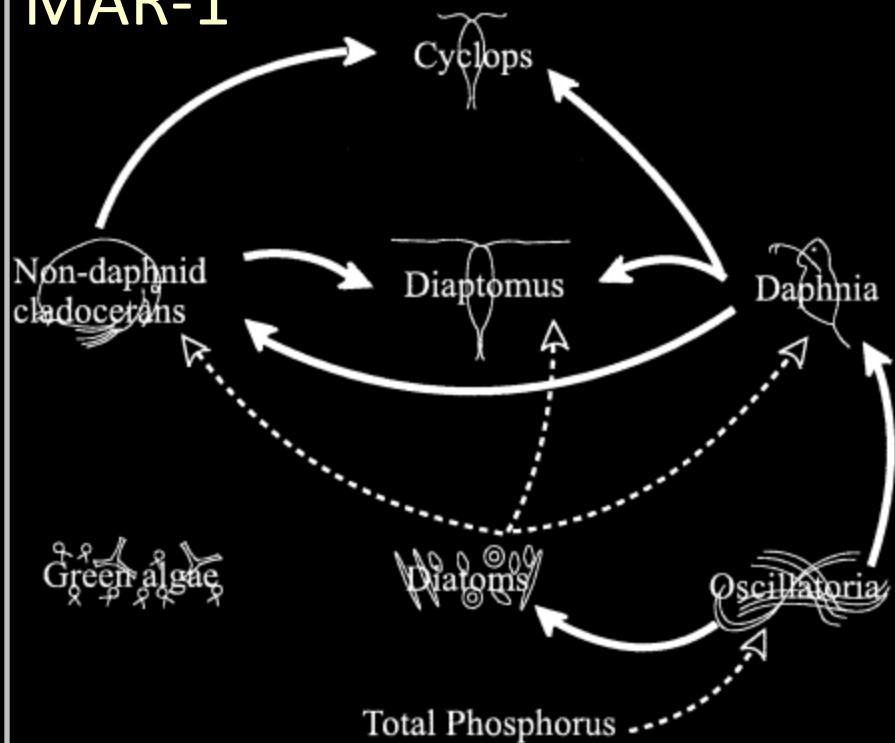


Interaction webs from MAR-1 analysis

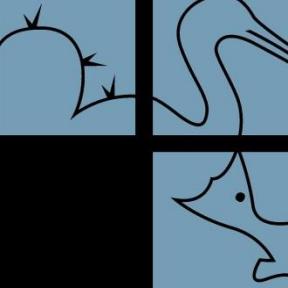
Conceptual



MAR-1



Hampton et al. 2006



Data

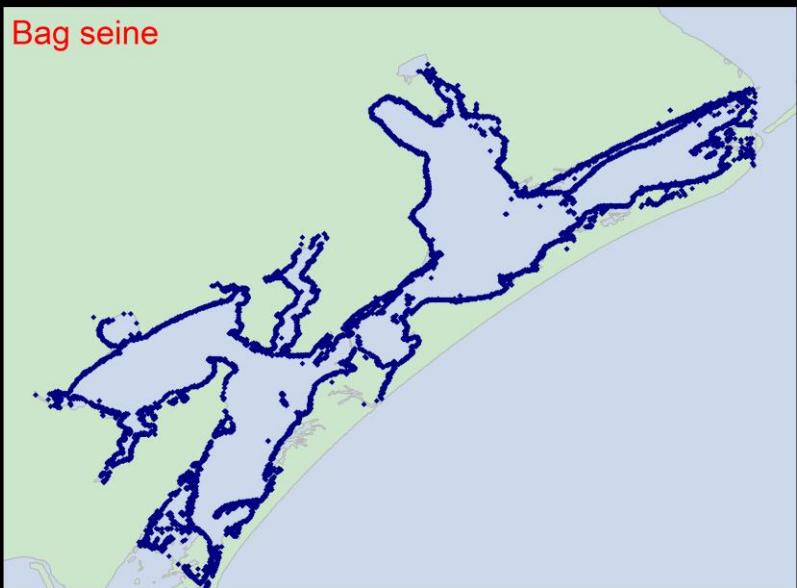
Data type	Source
Species abundance time-series	TPWD Coastal Fisheries monitoring program
Water quality parameters	TPWD Coastal Fisheries monitoring program Mission-Aransas NERR System-Wide Monitoring Program Texas Coastal Ocean Observation Network
Meteorological data	Mission-Aransas NERR System-Wide Monitoring Program Texas Coastal Ocean Observation Network NOAA National Climatic Data Center
Rain gauge data	U.S. Geological Survey
River flow gauge data	U.S. Geological Survey
Climate oscillation indices	NOAA Climate Prediction Center
Along-shore current patterns	Texas Automated Buoy System
Commercial landing data	Marine Aquatic Products Reports (TPWD)

TPWD Survey Data

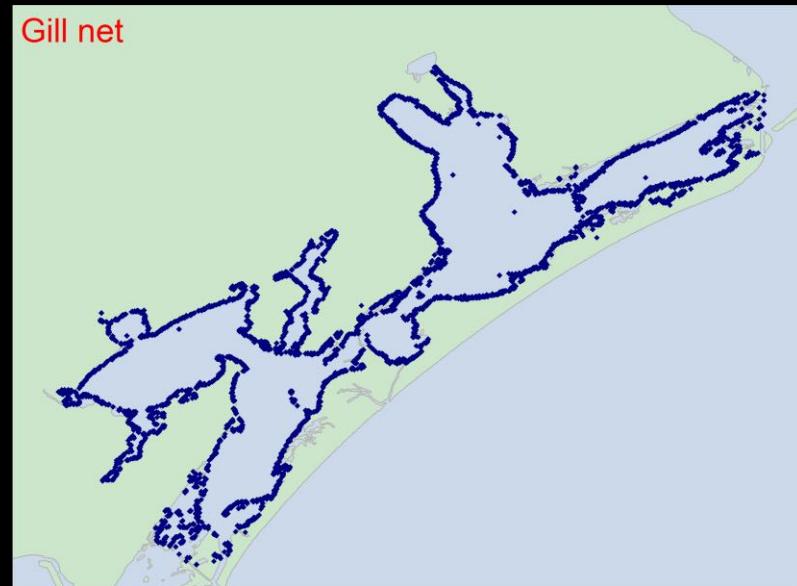
Otter trawl Data
(1982 – 2013)



Bag seine Data (1976 – 2013)



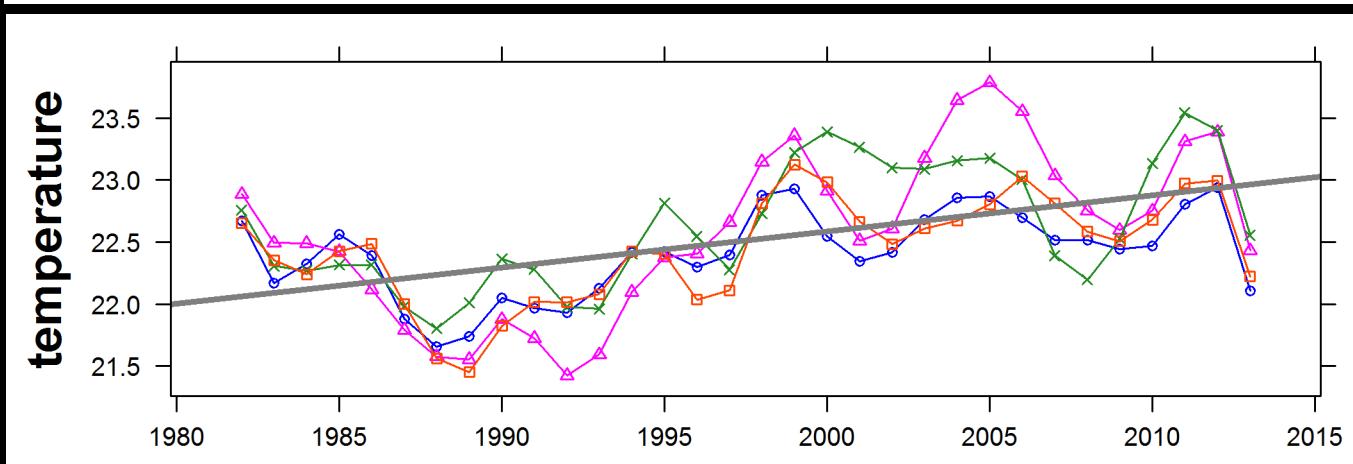
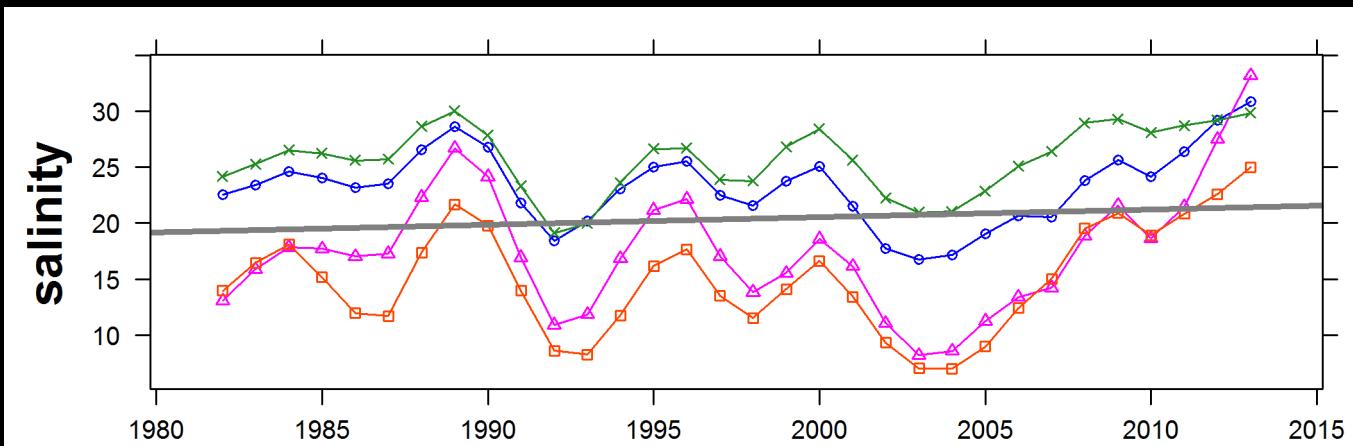
Gill net Data
(1975 – 2013)



Trawl Data

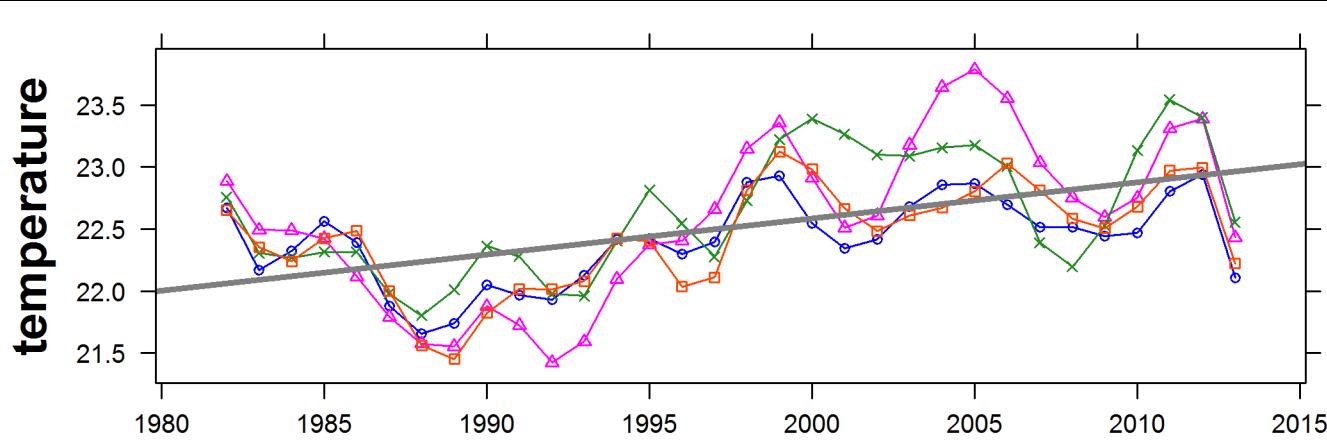
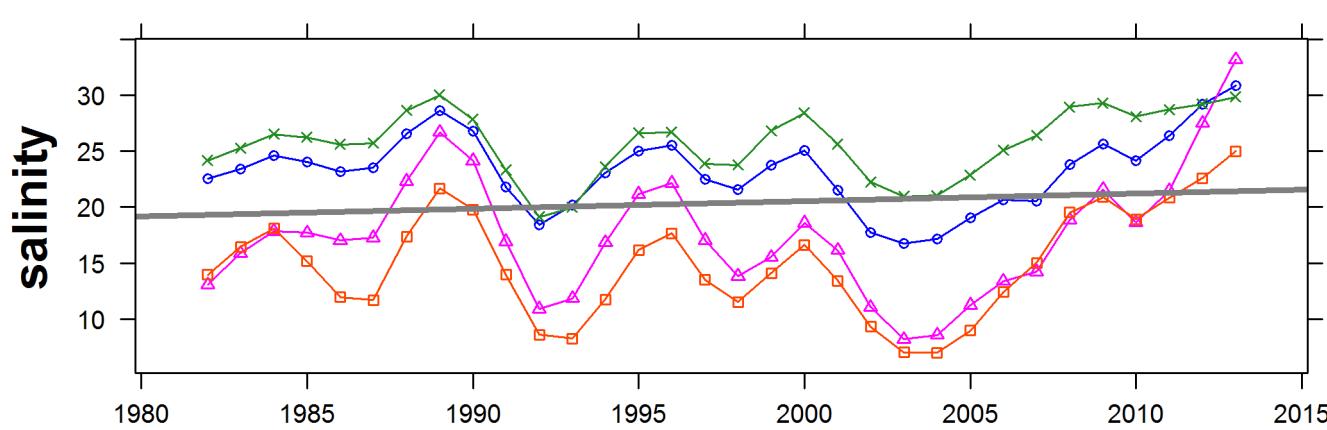
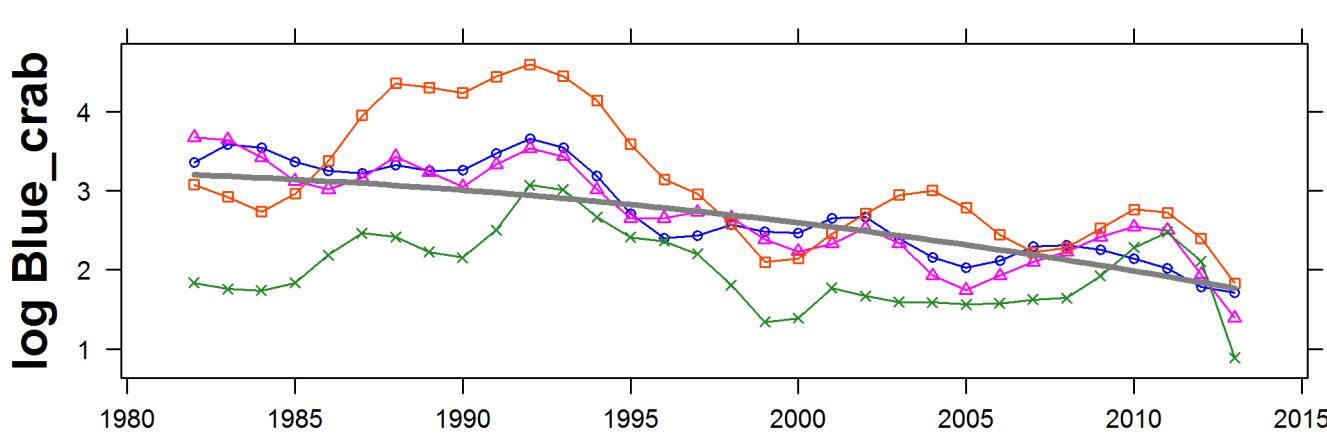
Yearly Means

Aransas Bay ○
Copano Bay ▲
Espirito Santo Bay ×
San Antonio Bay □



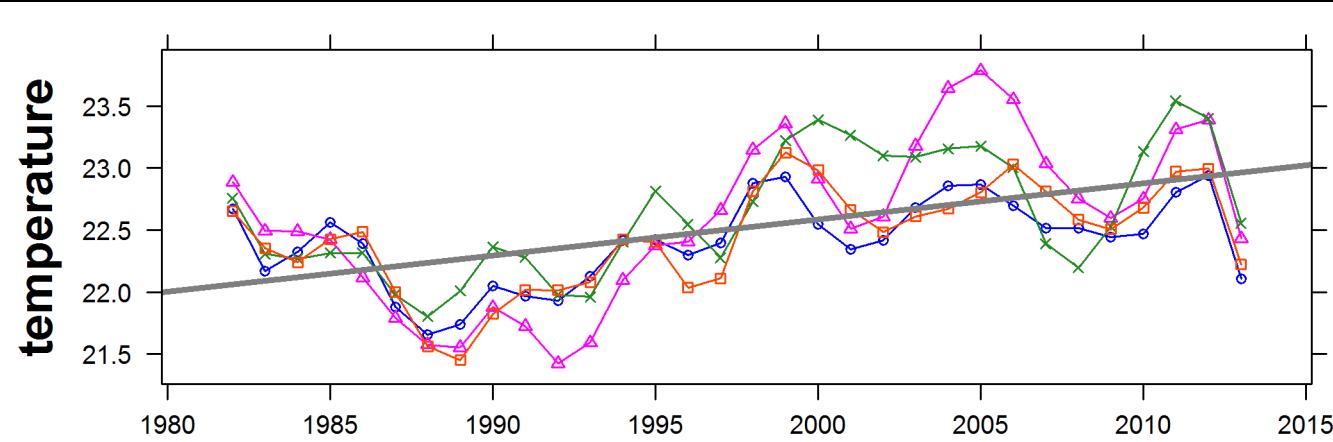
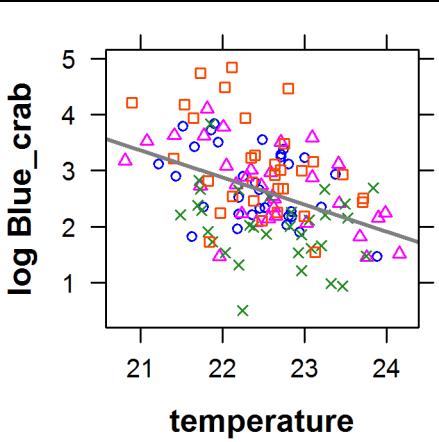
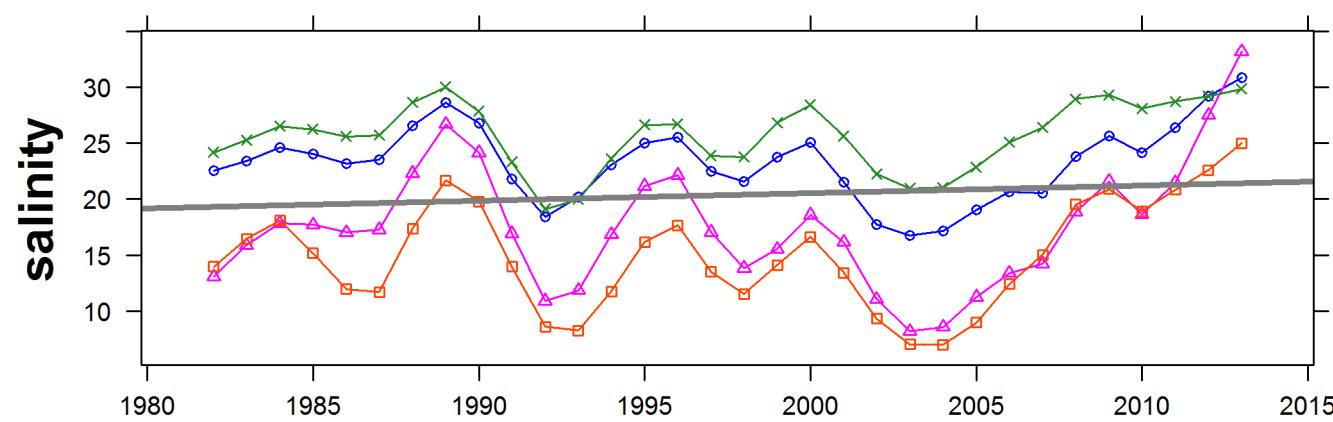
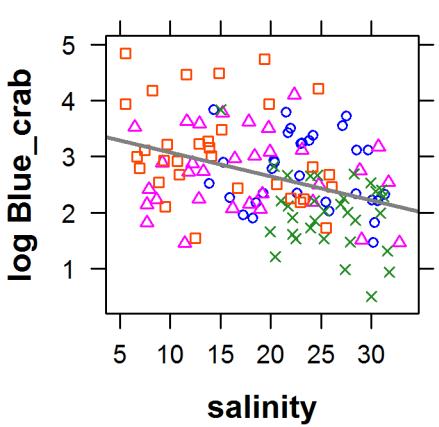
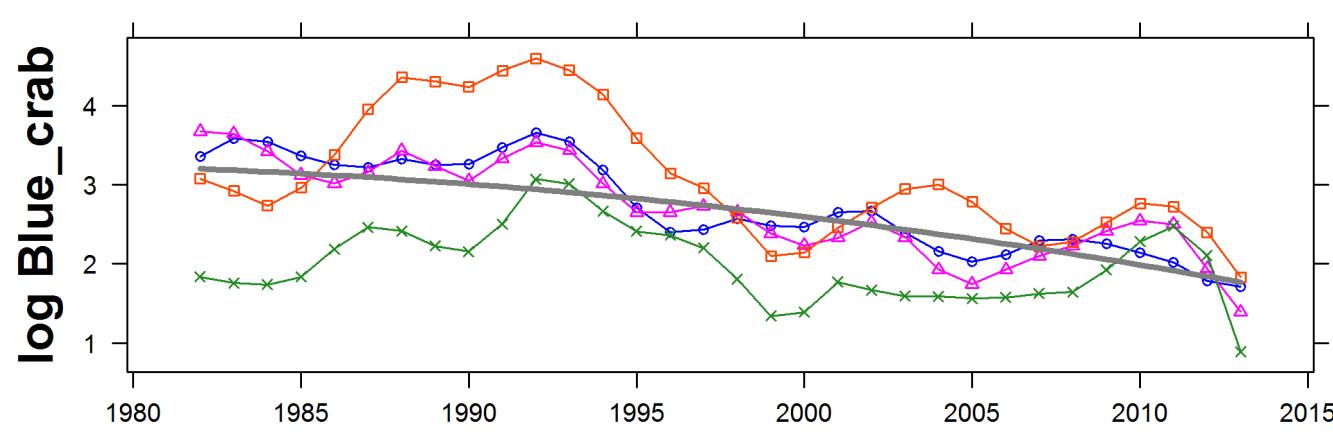
Trawl Data Yearly Means

Aransas Bay
Copano Bay
Espirito Santo Bay
San Antonio Bay



Trawl Data Yearly Means

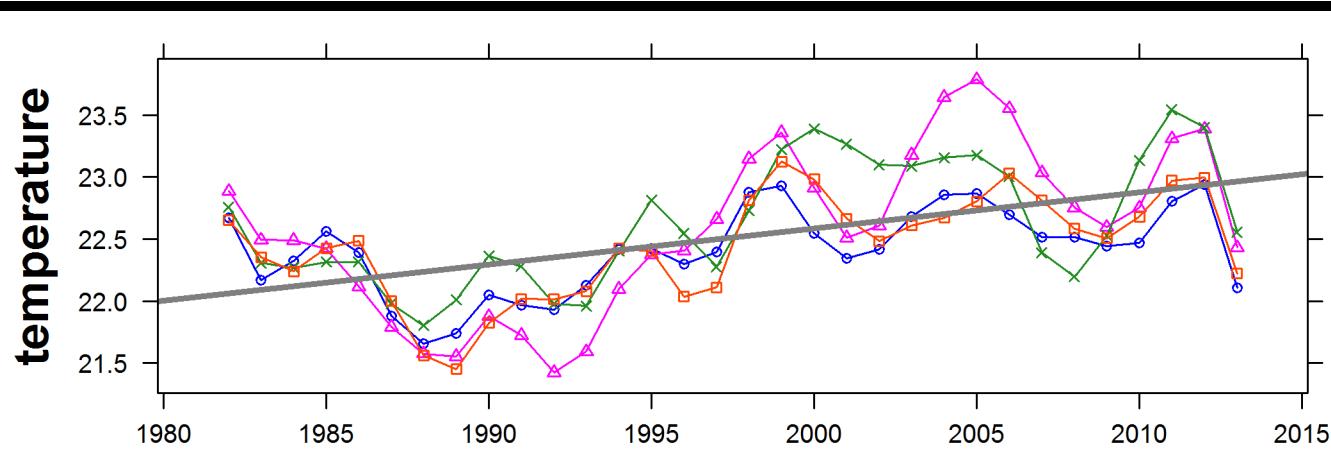
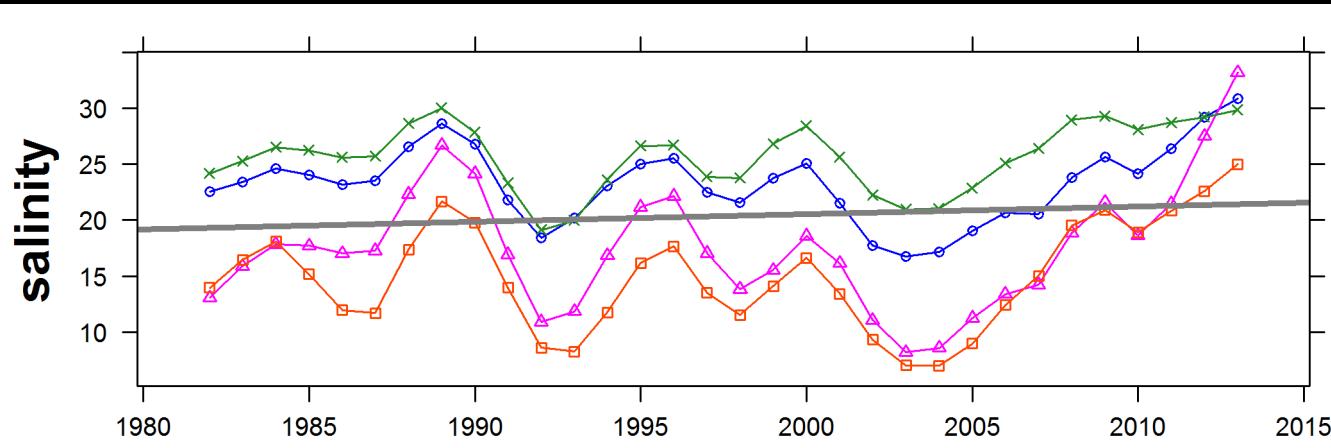
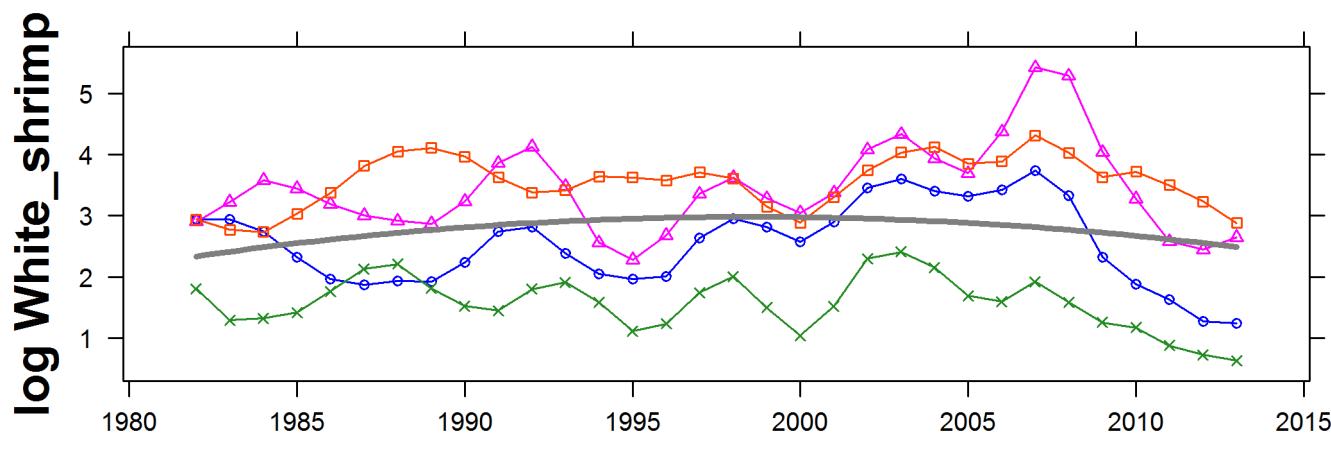
Aransas Bay ○
Copano Bay ▲
Espirito Santo Bay ×
San Antonio Bay □



Trawl Data Yearly Means

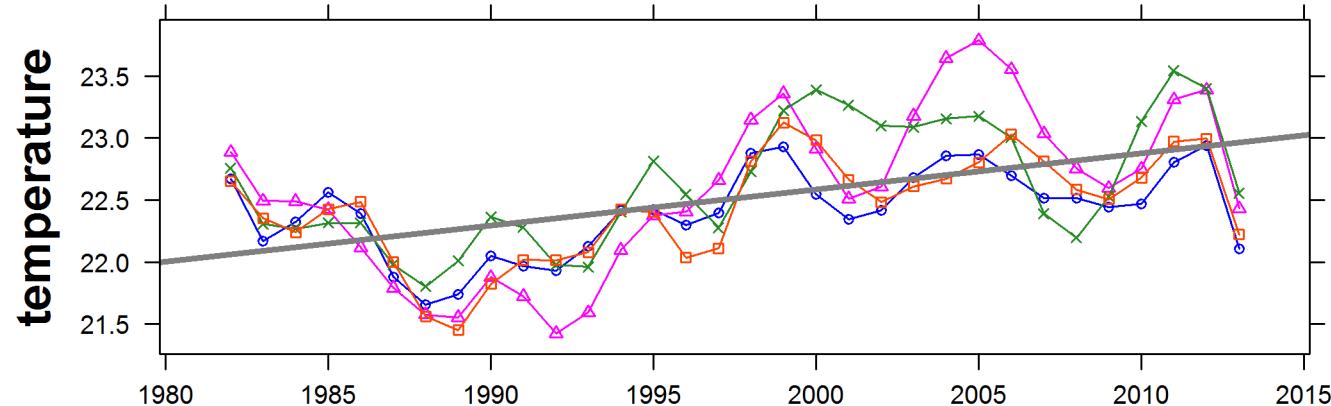
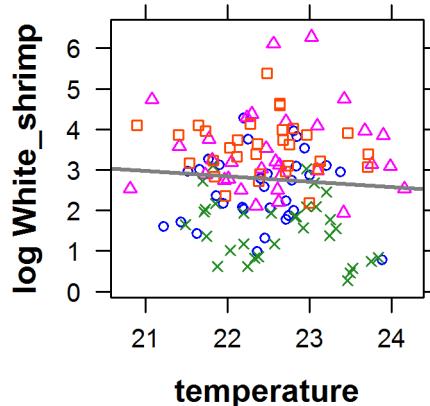
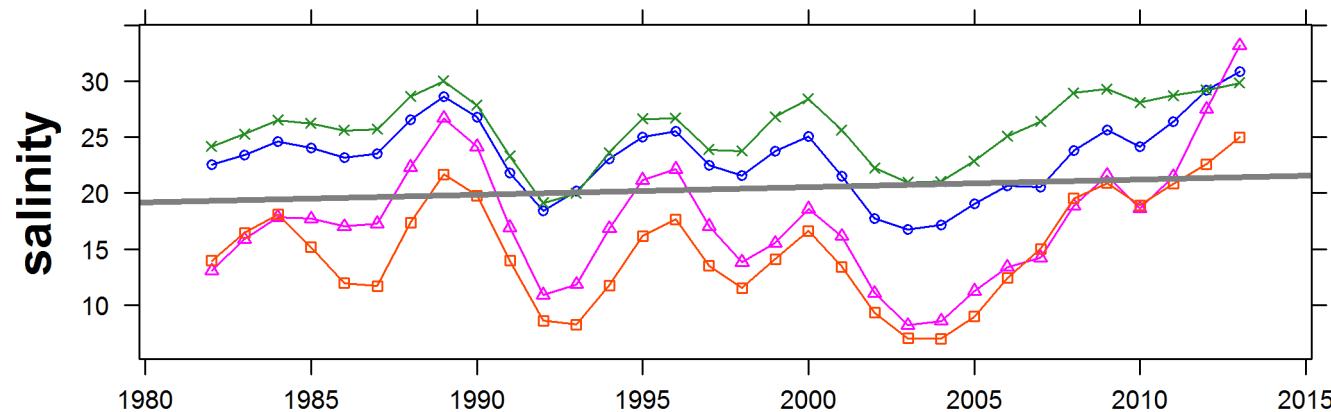
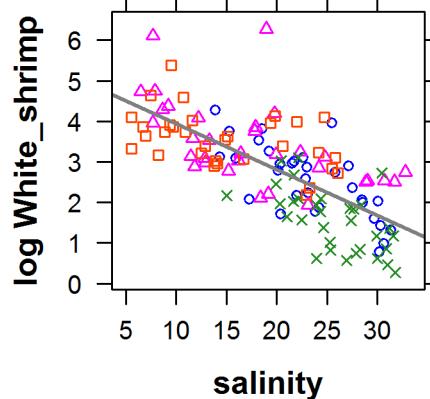
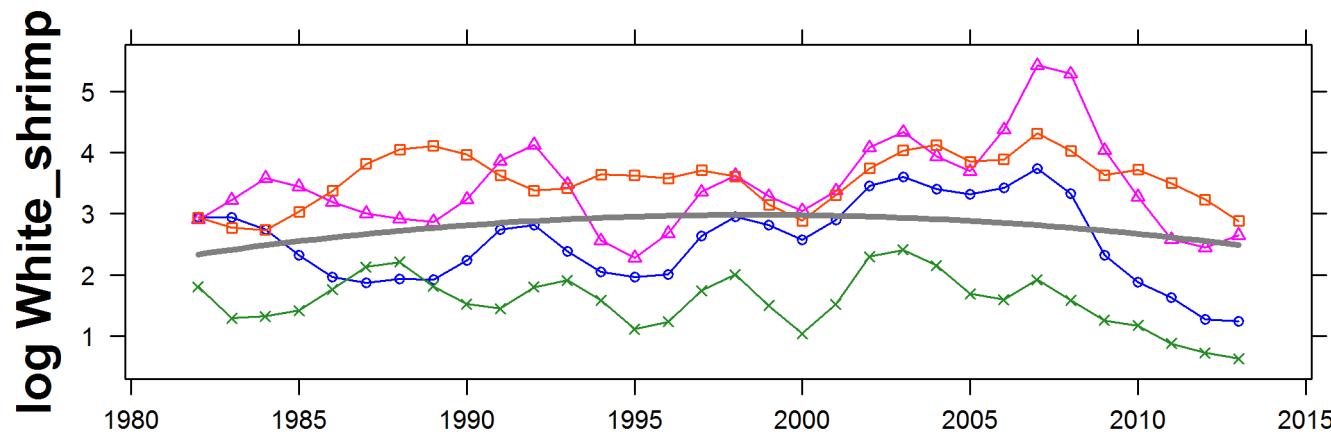
Aransas Bay
Copano Bay
Espirito Santo Bay
San Antonio Bay

○ ▲ × □

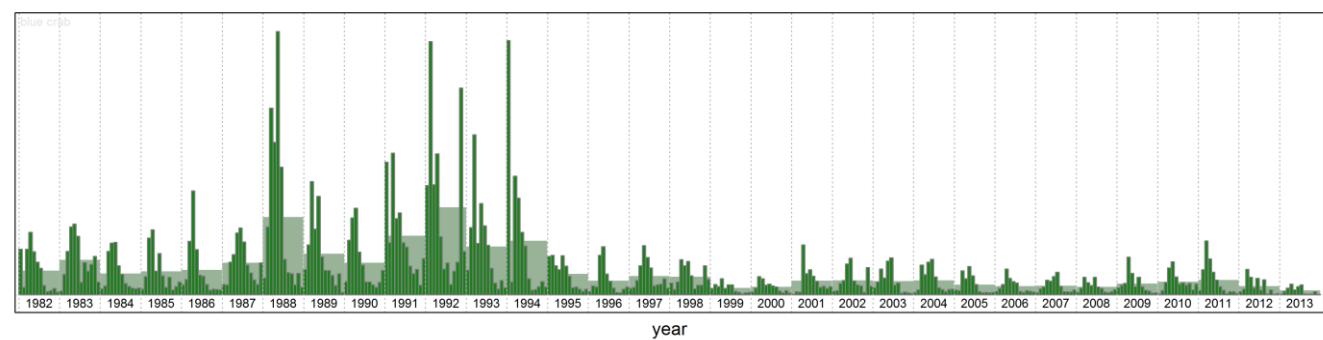


Trawl Data Yearly Means

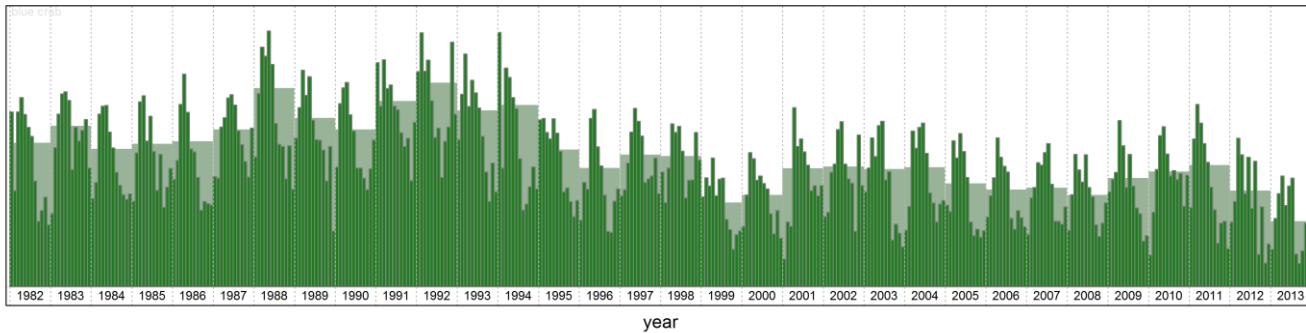
Aransas Bay ○
Copano Bay ▲
Espirito Santo Bay ×
San Antonio Bay □



Blue Crab trawl data

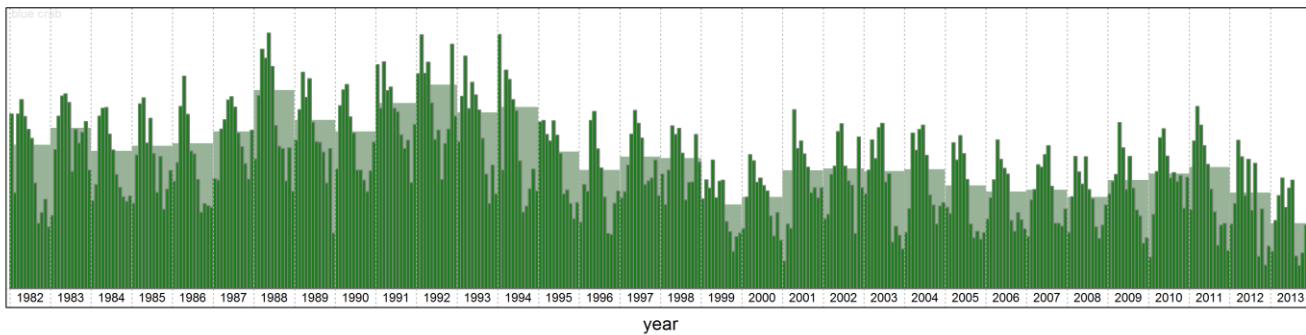


Blue Crab trawl data

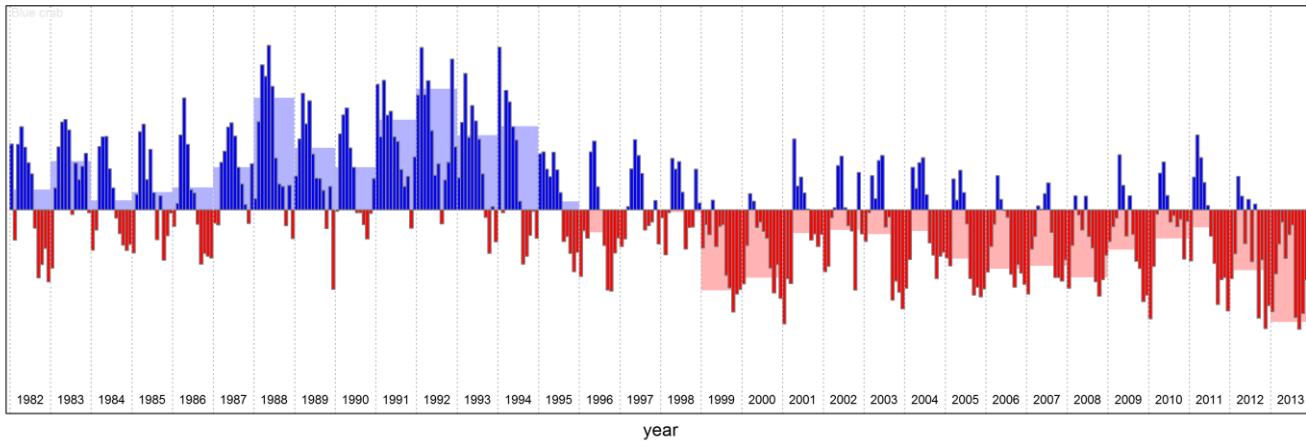


Log-transform

Blue Crab trawl data

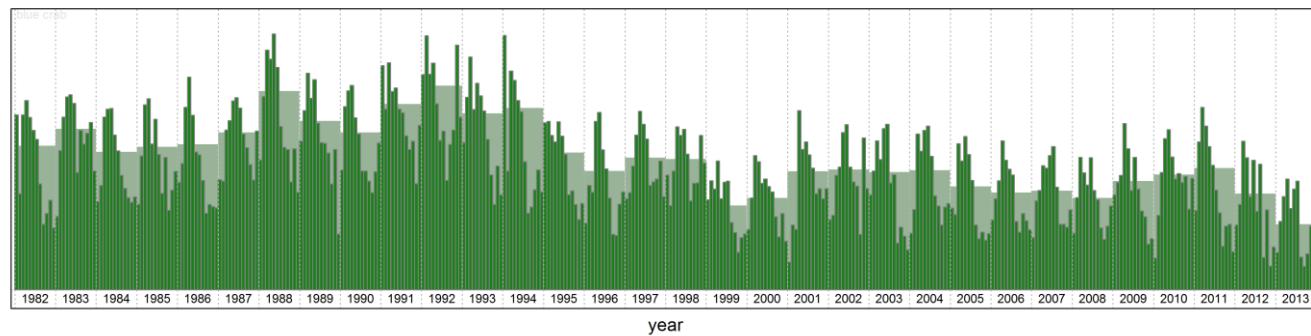


Log-transform

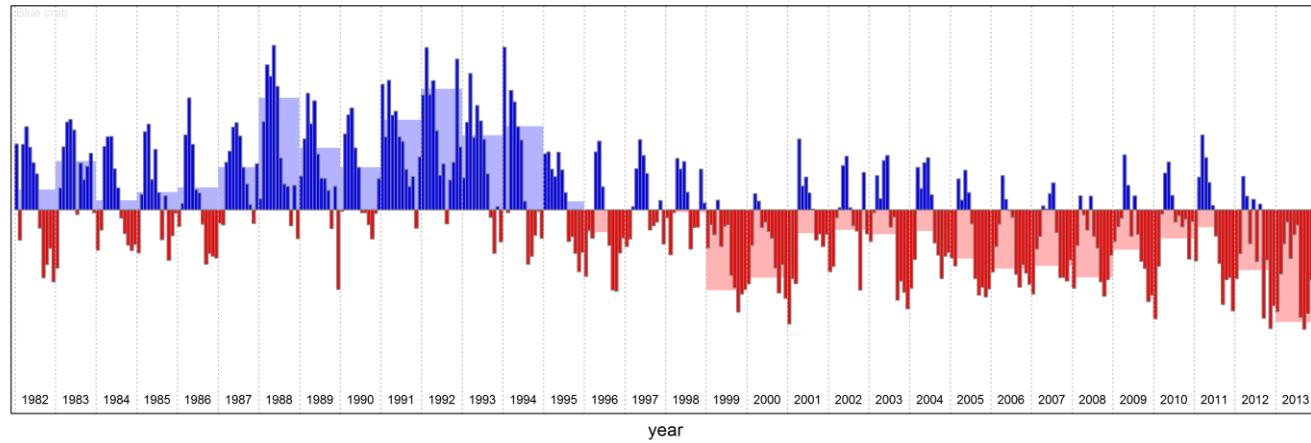


Z-score

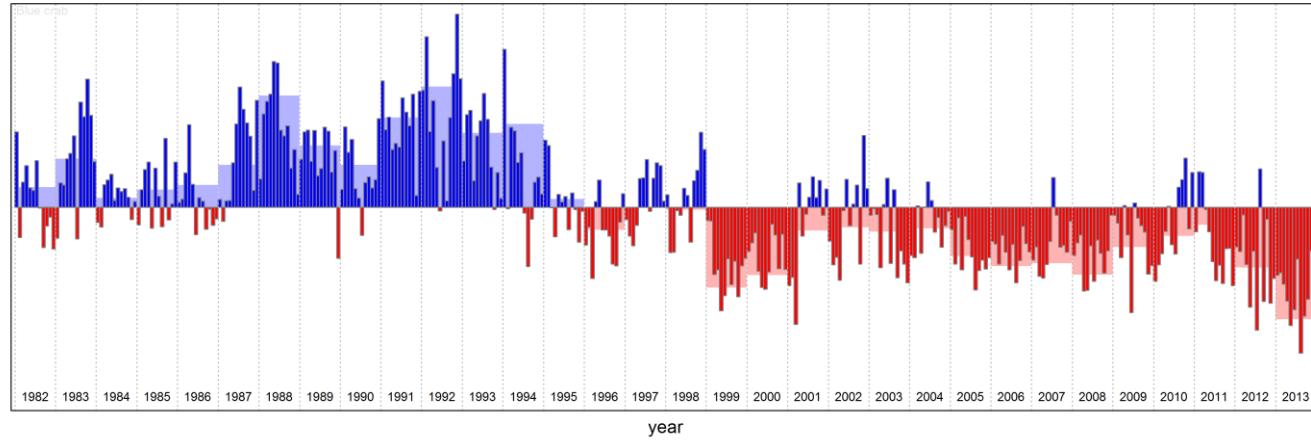
Blue Crab trawl data



Log-transform



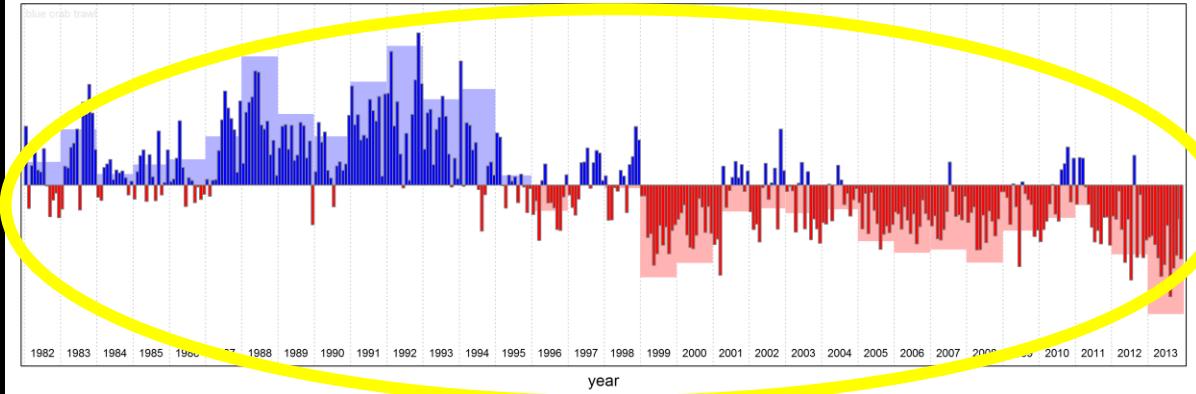
Z-score



Z-score w/
seasonal trend
removal

MAR-1 model

Blue crab



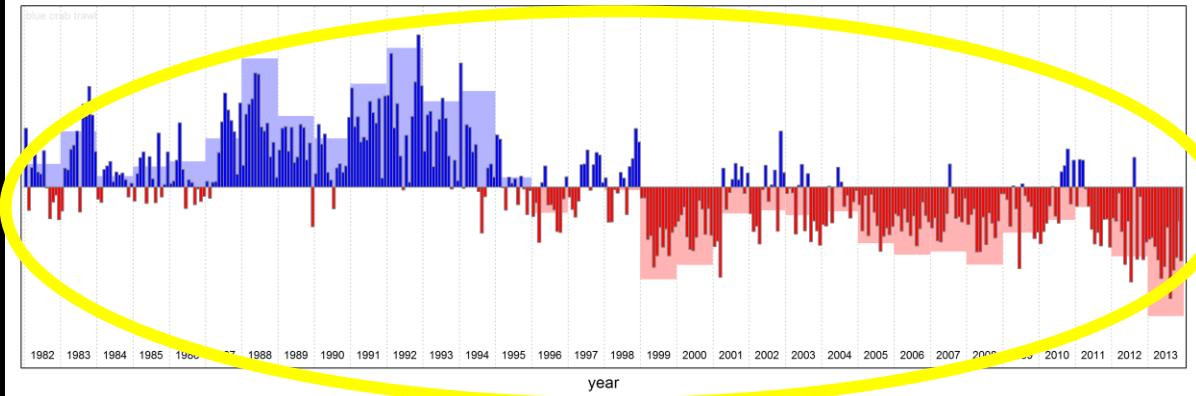
Species

Environmental

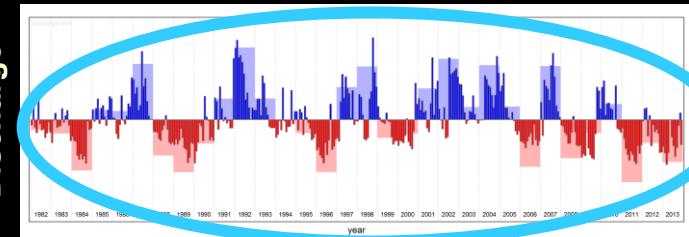
Species	1	2	3	...	p	1	...	q
1	$b_{1,1}$	$b_{1,2}$	$b_{1,3}$	...	$b_{1,p}$	$c_{1,1}$	...	$c_{1,q}$
2	$b_{2,1}$	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	$c_{2,1}$	...	$c_{2,q}$
3	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$

MAR-1 model

Blue crab



River
Discharge



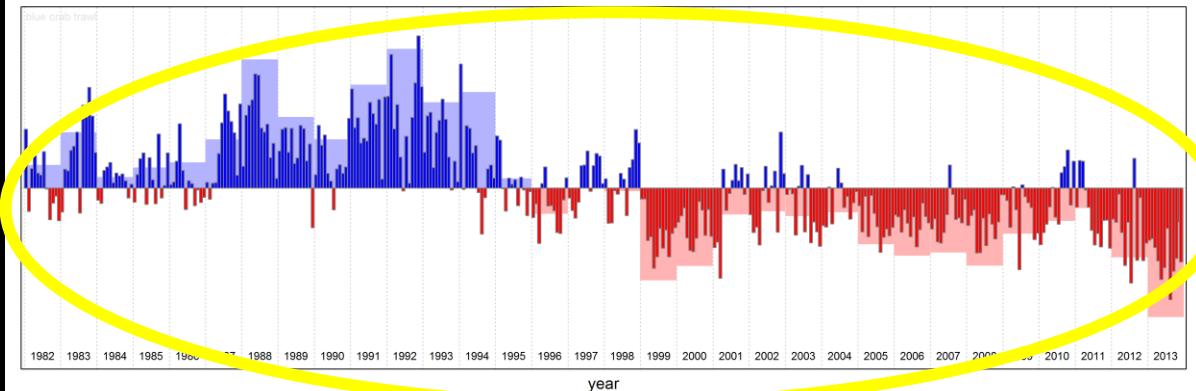
Species

Environmental

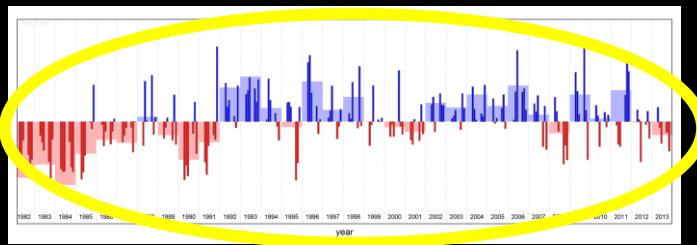
Species	1	2	3	...	p	1	...	q
1	$b_{1,1}$	$b_{1,2}$	$b_{1,3}$	...	$b_{1,p}$	$c_{1,1}$	...	$c_{1,q}$
2	$b_{2,1}$	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	$c_{2,1}$	...	$c_{2,q}$
3	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$

MAR-1 model

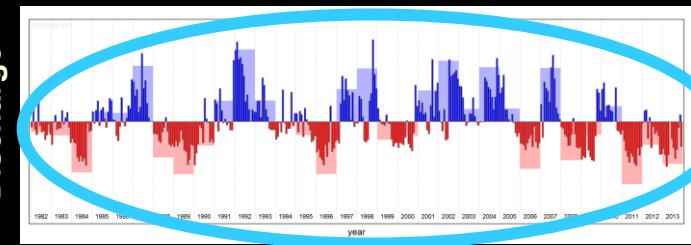
Blue crab



Red drum



River Discharge



Species

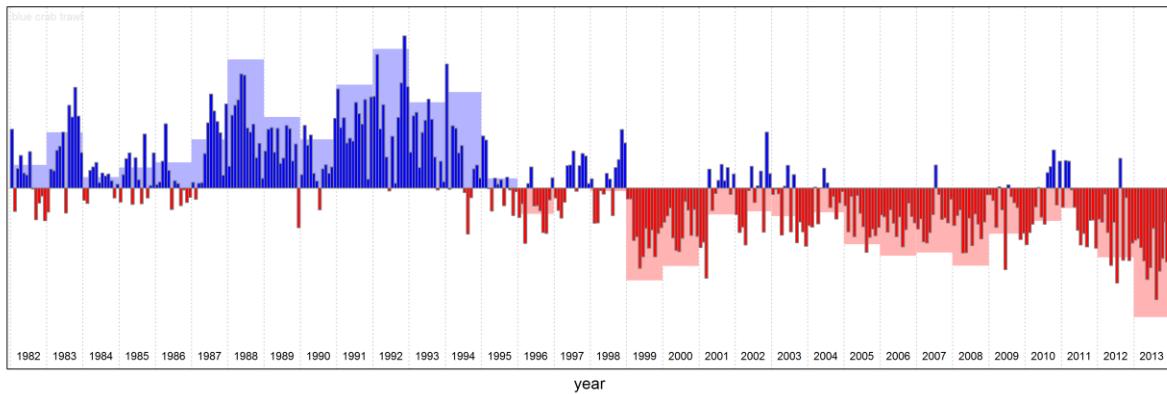
2

Environmental

Species	1	2	3	...	p	1	...	q
1	$b_{1,1}$	$b_{1,2}$	$b_{1,3}$	...	$b_{1,p}$	$c_{1,1}$	...	$c_{1,q}$
2	$b_{2,1}$	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	$c_{2,1}$	...	$c_{2,q}$
3	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$

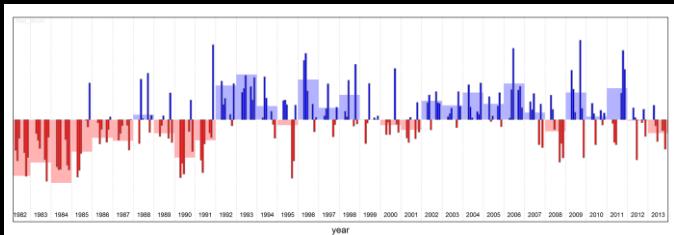
MAR-1 model

Blue crab

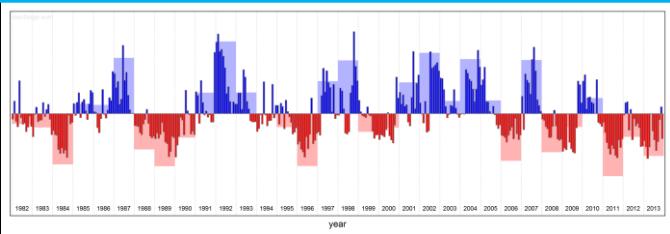


Variates

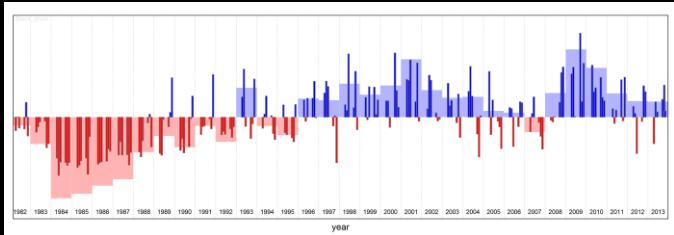
Red drum



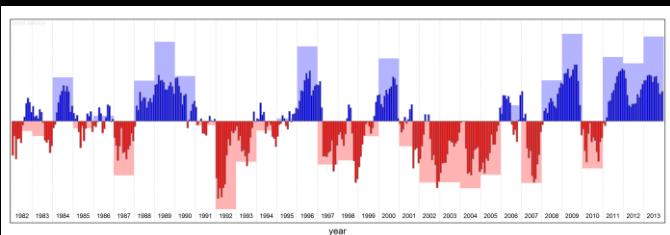
River Discharge



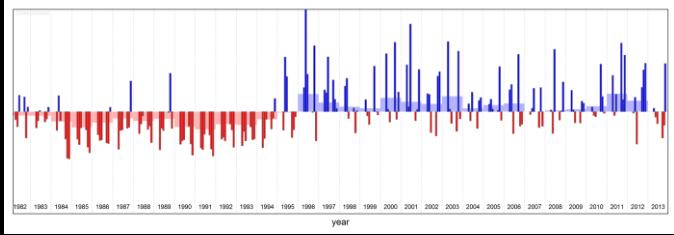
Black drum



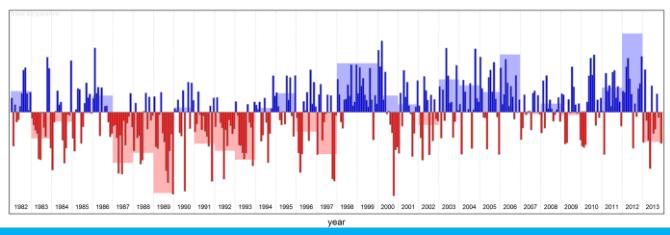
Salinity



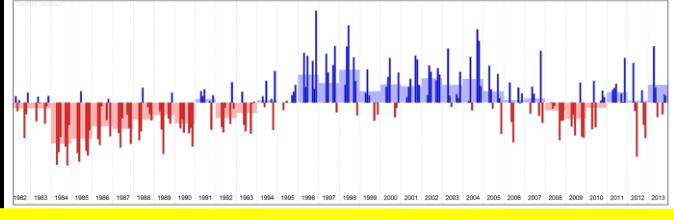
Sheepshead



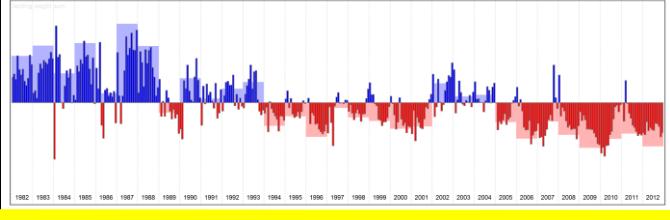
Temperature



Spotted seatrout



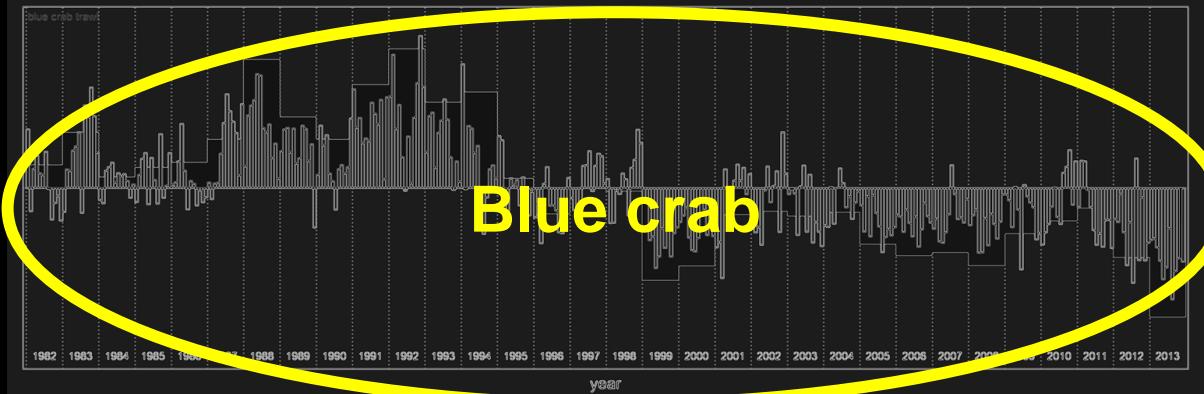
Commercial Landing



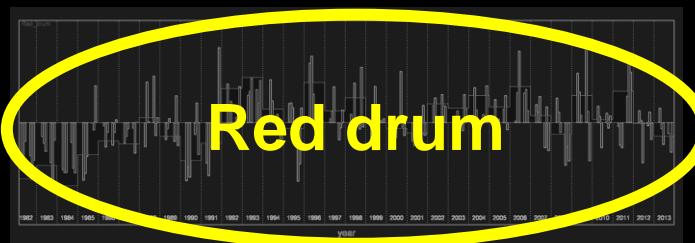
Co-variates

MAR-1 model

Blue crab



Red drum



River Discharge



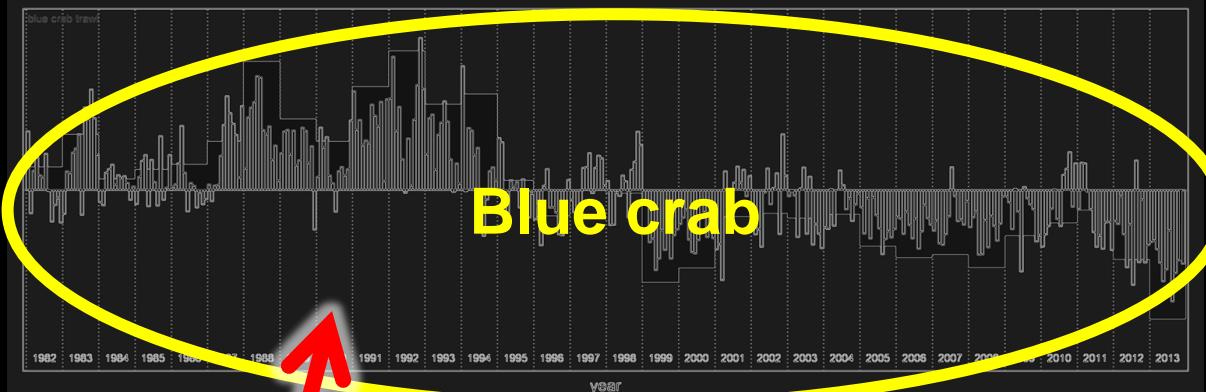
Species

Environmental

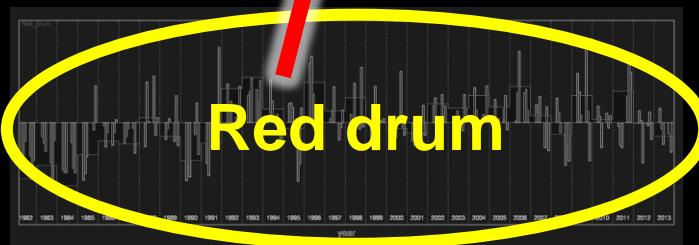
Species	Blue crab	Red drum	Black drum	...	p	Discharge	...	q
Blue crab	$b_{1,1}$	$b_{1,2}$	$b_{1,3}$	...	$b_{1,p}$	$c_{1,1}$	...	$c_{1,q}$
Red drum	$b_{2,1}$	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	$c_{2,1}$	...	$c_{2,q}$
Black drum	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$

MAR-1 model

Blue crab



Red drum



River Discharge



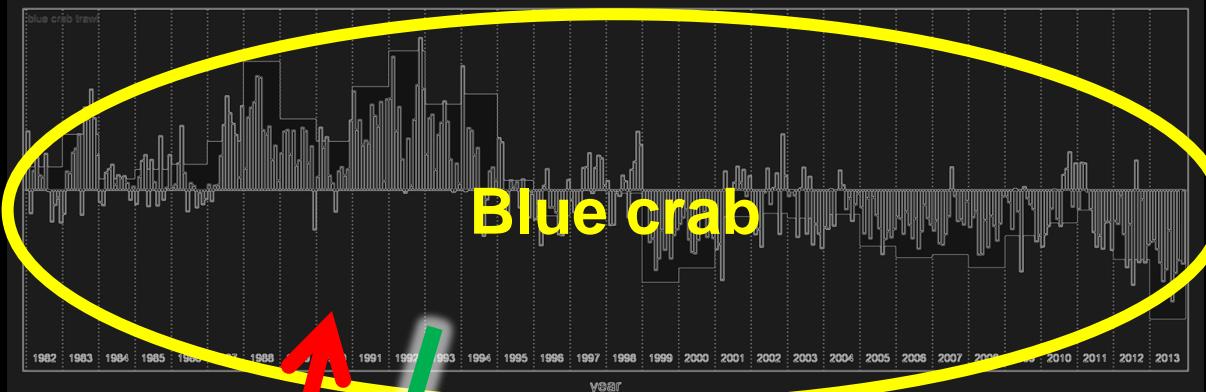
Species

Environmental

Species	Blue crab	Red drum	Black drum	...	p	Discharge	...	q
Blue crab	$b_{1,1}$	-b	$b_{1,3}$	...	$b_{1,p}$	$c_{1,1}$	...	$c_{1,q}$
Red drum	$b_{2,1}$	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	$c_{2,1}$	...	$c_{2,q}$
Black drum	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$

MAR-1 model

Blue crab



Red drum



River Discharge



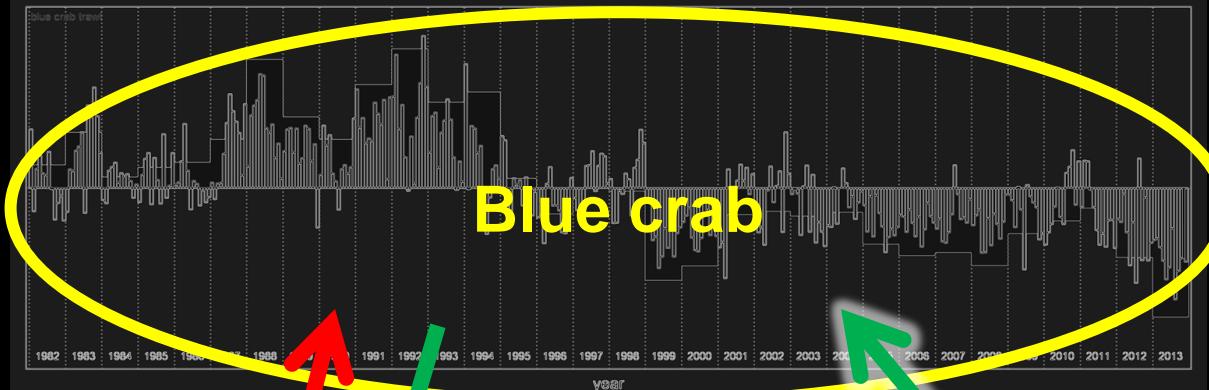
Species

Environmental

Species	Blue crab	Red drum	Black drum	...	p	Discharge	...	q
Blue crab	$b_{1,1}$	$b_{1,2}$	$b_{1,3}$	...	$b_{1,p}$	$c_{1,1}$	...	$c_{1,q}$
Red drum	$+b$	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	$c_{2,1}$	...	$c_{2,q}$
Black drum	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$

MAR-1 model

Blue crab



Red drum



River
Discharge



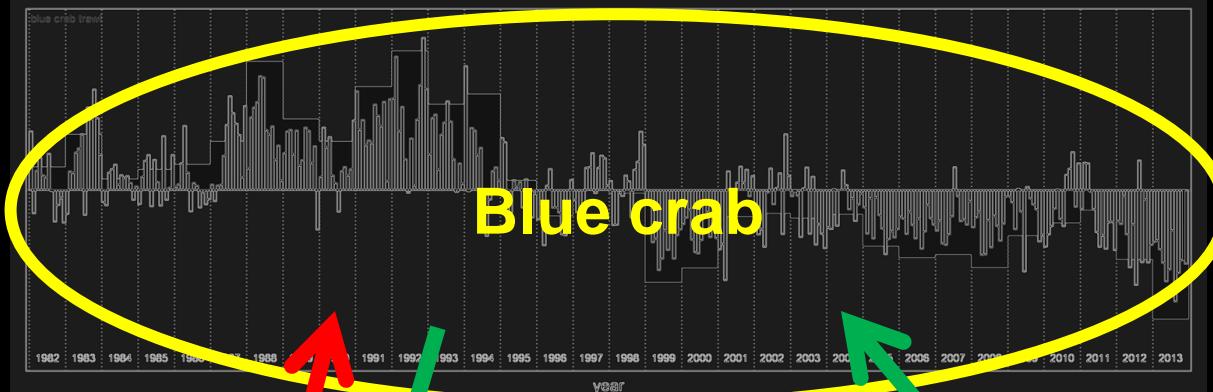
Species

Environmental

Species	Blue crab	Red drum	Black drum	...	p	Discharge	...	q
Blue crab	$b_{1,1}$	$b_{1,2}$	$b_{1,3}$	...	$b_{1,p}$	$+c$	...	$c_{1,q}$
Red drum	$b_{2,1}$	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	$c_{2,1}$	...	$c_{2,q}$
Black drum	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$

MAR-1 model

Blue crab



Red drum



River
Discharge



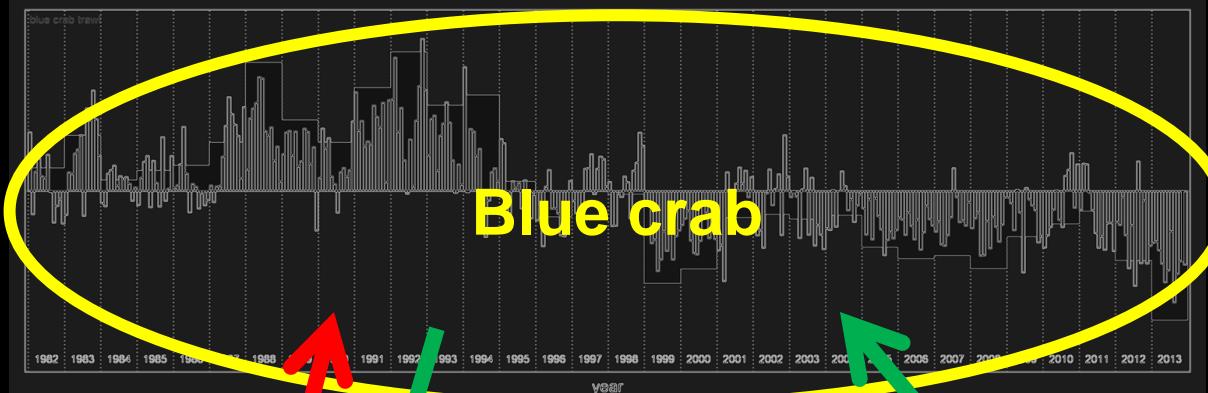
Species

Environmental

Species	Blue crab	Red drum	Black drum	...	p	Discharge	...	q
Blue crab	$b_{1,1}$	$b_{1,2}$	$b_{1,3}$	...	$b_{1,p}$	$c_{1,1}$	...	$c_{1,q}$
Red drum	$b_{2,1}$	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	$-c$	...	$c_{2,q}$
Black drum	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$

MAR-1 model

Blue crab



Red drum



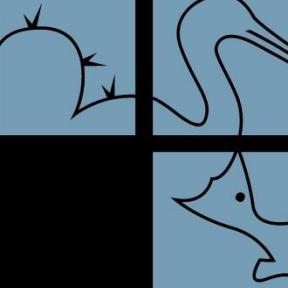
River
Discharge



Species

Environmental

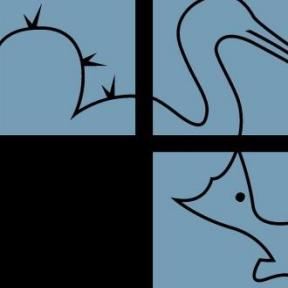
Species	Blue crab	Red drum	Black drum	...	p	Discharge	...	q
Blue crab	$b_{1,1}$	$-b$	$b_{1,3}$	...	$b_{1,p}$	$+c$	...	$c_{1,q}$
Red drum	$+b$	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	$-c$	...	$c_{2,q}$
Black drum	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$



Model results

- Interactions at different time lags

	Species					Environmental		
Species	Blue crab	Red drum	Black drum	...	p	Discharge	...	q
Blue crab	$b_{1,1}$	-b	$b_{1,3}$	...	$b_{1,p}$	+c	...	$c_{1,q}$
Red drum	+b	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	-c	...	$c_{2,q}$
Black drum	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$



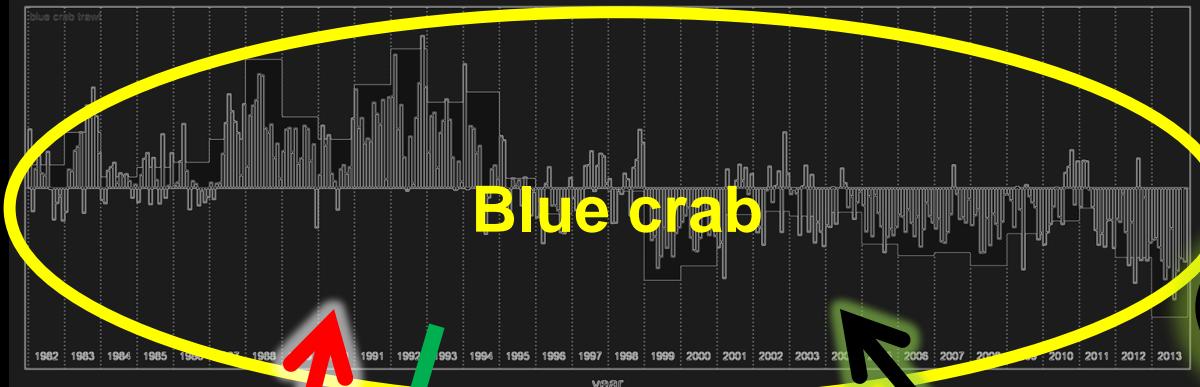
Model results

- Interactions at different time lags
- Indirect effects

		Species					Environmental		
Species		Blue crab	Red drum	Black drum	...	p	Discharge	...	q
Blue crab		$b_{1,1}$	-b	$b_{1,3}$	...	$b_{1,p}$	+c	...	$c_{1,q}$
Red drum		+b	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	-c	...	$c_{2,q}$
Black drum		$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...	
p		$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$

MAR-1 model

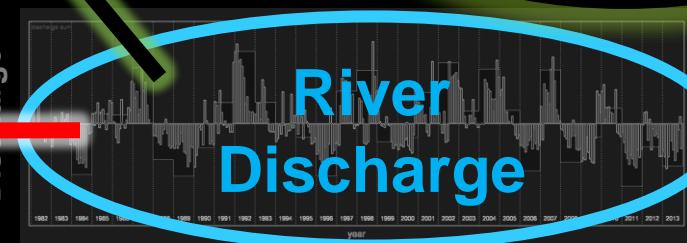
Blue crab



Red drum



River
Discharge

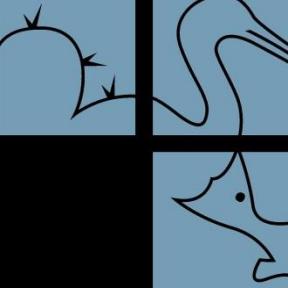


Indirect
effects

Species

Environmental

Species	Blue crab	Red drum	Black drum	...	p	Discharge	...	q
Blue crab	$b_{1,1}$	$-b$	$b_{1,3}$	...	$b_{1,p}$		...	$c_{1,q}$
Red drum	$+b$	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$		$-c$	$c_{2,q}$
Black drum	$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...
p	$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$



Model results

- Interactions at different time lags
- Indirect effects
- System stability under different conditions

		Species					Environmental		
Species		Blue crab	Red drum	Black drum	...	p	Discharge	...	q
Blue crab		$b_{1,1}$	-b	$b_{1,3}$	...	$b_{1,p}$	+c	...	$c_{1,q}$
Red drum		+b	$b_{2,2}$	$b_{2,3}$	...	$b_{2,p}$	-c	...	$c_{2,q}$
Black drum		$b_{3,1}$	$b_{3,2}$	$b_{3,3}$	...	$b_{3,p}$	$c_{3,1}$	...	$c_{3,q}$
...	
p		$b_{p,1}$	$b_{p,2}$	$b_{p,3}$	...	$b_{p,p}$	$c_{p,1}$	...	$c_{p,q}$